



Kaufman - Trading Systems & Methods -

Chap03 22-25

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pending on the number of coefficients selected), determine the errors in the estimation, and then approximate those errors using a moving average. it will next look at the resulting new error series, attempt to estimate and correct the errors in that one, and repeat the process until it accounts for all price movement.

To determine when an ARIMA process is completed, three tests are performed at the end of each estimation pass:

- a. Compare the change in the coefficient value. If the last estimation has caused little or no change in the value of the coefficient(s), the model has successfully converged to a solution.
- b. Compare the sum of the squares of the error. If the error value is small or if it stays relatively unchanged, the model is completed.
- c. Perform a set number of estimations. Unless a maximum number of estimations is set, an ARIMA process might continue indefinitely. This "safe" check is necessary in the event the model is not converging to a solution.

Once completed, the errors can be examined using an t -statistic to check for any trend. If one exists, an additional moving average term may be used to eliminate it.

Forecast Results

Once the coefficients have been determined, they are used to calculate the forecast value. These forecasts are most accurate for the next day, and should be used with less confidence for subsequent days (see Figure 310).

What if the forecast does not work? First, the process should be checked to be certain that it was performed properly. Pay particular attention to the removal of trends using the correlogram. Next, check the data used in the process. if the data sample is changing (which can be observed on a price chart), select either a shorter or longer period that contains more homogeneous data, that is, data similar to the current market period.

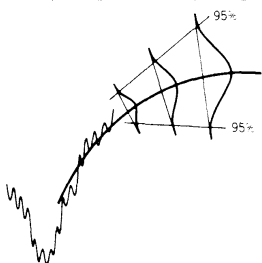
Trading Strategies

In the article that originally piqued the interest of traders,' Anon uses a 5dayahead forecast. If the ARIMA process forecasts an uptrend and if prices fall below the forecast value.

'Louisj. Anon,CatchShortTerm Profits with ARIMA."

(December 1981

FIGURE310 ARIMA forecast becomes less accurate as it is used farther ahead.



the market can be bought with added confidence (expecting lower risk and more profit). This technique of selecting better entry points may compensate for some of the inaccuracies latent in any forecasting method. The danger of this approach is that prices may continue to move counter to the forecast, so that caution and a stoploss are also necessary..

Following the Trend

Use the 1dayahead forecast to determine the trend position. if the forecast is for higher prices, a long position should be held; if it is predicting lower prices, shorts are necessary.

Countertrend Indicator

Use the ARIMA confidence bands to determine overbought/Oversold levels. Not only. can a long position be entered when prices penetrate the lowest 95% confidence band. but they can be closed out when they return to the normal 50% level. A conservative trader will enter the market only in the direction of the ARIMA trend forecast. As shown in Figure 310, if the trend is up, only the penetrations of the lower band will be used to enter new long positions.

Use of Highs and Lows

Both the implied highs and lows as well as the independently forecasted highs and lows can be the basis for other interesting strategies.' The following two are used with intraday prices.

- 1 . Using confidence bands based on the closing prices, buy an intraday penetration of the expected high or sell a penetration of the expected low, and liquidate the position on the close. Use a stoploss. Consider taking positions only in the direction of the ARIMA trend.
2. Using the separate ARIMA models based on the daily high and low prices, buy a penetration of the 50% level of the high and sell a penetration of the 50% level of the lows. Liquidate positions on the close. Use a stoploss.

Slope

The onedayahead forecast suggested in "Following the Trend," a few paragraphs earlier. is essentially a projection of the slope of the trendline. Because of the frequent erratic price movement, also called noise, the purpose of directional analysis, whether regression or moving averages, is to uncover the true direction of prices. Therefore, the slope of the trendline, or the direction of the regression forecast, is the logical answer.

The popular alternate for triggering a new directional signal is a price penetration of an envelope or band value. Using regression analysis that band can be replaced by a confidence level. While it is true that the number of random, or false, penetrations declines as the confidence band gets farther away from the trendline, so does the total number of penetrations. At any band distance there are still a large number of erroneous signals. The slope itself should be viewed as the best approximation of direction.

Kalman Filters

Kalman offers an alternative approach to ARIMA, allowing an underlying forecasting model (message model) to be combined with other timely information (observation model). The message model may be any trading strategy, moving average, or regression approach. The observation model may be the floor broker's opening calls, market liquidity', or, in the case of existing foreign markets, earlier trading activity all of which have been determined to have some overriding importance in forecasting.

John E Kepka, "Trading With ARIMA Forecasts, Technical Analysis of Stocks & Commodities (August 1985).

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Assume that the original forecast (message) model can be described as

$$M(P_t) = c_f P_{t-1} + me_t$$

and the observation model as

$$O(P_t) = c_o P_t + oe_t$$

where me and oe are the message and observation model errors, respectively. The combined forecast would then use the observation model error to modify the result

$$P'_{t+1} = c_f P'_t + K_{t+1} oe_t$$

where K is the Kalman gain coefficient,¹⁰ a factor that

LINEAR REGRESSION MODEL

A linear regression, or straightline fit, could be the basis for a simple trading strategy similar to a moving average. For example, an n day linear regression, applied to the closing prices, could be used with the following rules:

1. Buy when the closing price moves above the forecasted value of today's close.
2. Sell when the closing price moves below the forecasted value of today's close.

There is an important difference between a model based on linear regression and one founded on a moving average. There is no lag in a regression strategy. If prices continue higher at the same rate, a moving average system will initially lag behind, then increase at the same rate. The lag creates a safety zone to absorb some changes in the direction of prices, without getting stopped out. (See Chapter 4 for a complete discussion of moving averages, and Chapter 5 for a comparison of a Linear Regression

Slope trading system with five other popular trending methods.)

A regression model, on the other hand, identifies a change of direction sooner by measuring future movement against a straightline projection in which the current price value has little influence. A steady price move, however, will place the fitted line right in the center of market movement, subject to frequent whipsaws. The area at which a uniform trend changes from one direction to another is a difficult case for a linear regression system (see **Figure 311**) and points out the need for using bands. Even with bands, the turning point of an orderly trend will appear to have much greater variance than during the direction period over the same calculation interval.

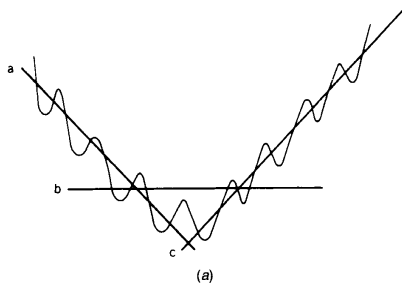
In **Figure 31 la** , the three positions of the regression line all show numerous penetrations of the price, resulting in many losing trades. This is natural because the regression line is fitted best when it goes through the center of price movement. For prices to remain on one side of a regression line it must be constantly accelerating or decelerating, an unlikely situation. it is possible that this approach would work better using very few calculation periods; however, the use of only a few days is inconsistent with the nature of such a statistical measurement, which gains significance with more data. Figure 311b shows the more practical use of a confidence band spaced equally around the regression line. Using a highconfidence band (e.g., 95%), it is possible to turn the erratic performance in Figure 31 la into two clearly identifiable trends. Interestingly, the use of a confi

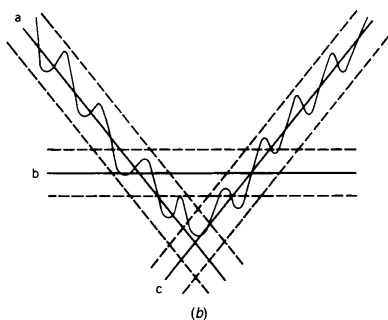
" For a more complete discussion, see Andrew D. Seidel and Philip D. Ginsberg's *Commodities Trading* (Prentice. Hall, Englewood Cliffs, NJ, 1983), or R.E. Kalman's 'A New Approach to Linear Filtering and Prediction Problems,' *Journal of Basic Engineering* (March 1960).

" These rules were used by Frank Hochheimer in *Computerized Trading Techniques* 1982 (Merrill Lynch Commodities, New York, 1982).

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FIGURE 311 Linear regression model. (a) Simple penetration of the regression lines. (b) Penetration of the channel formed by confidence bands.





dence band with the regression analysis looks remarkably similar to a channel on a standard bar chart.

Hochheimer's 1982 study, performed without a channel or confidence band, shows the best selection of the regression interval at 60 to 70 days (the maximum tested was 70 days). Silver had a remarkable 1,615 trades one each day. Only two markets showed average trade duration greater than 2 days. We can draw the conclusion that successful regression based systems seek out longer time periods.